Chapter 5
Cancer Cell Membrane-Coated Nanoparticles: Therapeutic Advancements and Hybrid Systems

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ABSTRACT

Cancer cell membrane-coated nanoparticles (CCM-NPs) offer enhanced tumor targeting, immune evasion, and improved therapeutic efficacy. Cancer cell membrane-coated nanoparticles leverage tumor-associated antigens and homotypic targeting mechanisms to preferentially accumulate at tumor sites, enhancing therapeutic precision. This study addresses these gaps by systematically evaluating CCM-NPs alongside other membrane types, elucidating their high drug loading efficiency (85–95%), tumor targeting capability, and moderate circulation half-life (15–25 hours). Importantly, CCM-NPs demonstrate substantial tumor growth inhibition (65–80%). The novelty lies in harnessing the homologous binding and antigen

DOI: 10.4018/979-8-3373-3765-4.ch005

presentation capacities of cancer membranes to improve targeted delivery. The metastasis suppression (45–65%), and survival benefits (up to 3.5-fold increase) in preclinical cancer models, outperform conventional nanoparticles. Overall, this work provides a rationale for advancing CCM-NPs, aiming to overcome clinical limitations.

INTRODUCTION

Cell membrane-coated nanoparticles (CCMNPs) represent a revolutionary biomimetic approach in cancer nanomedicine. CCMNP combines the targeting capabilities of natural cell membranes from leukocytes, erythrocytes, or tumor cells with the versatility of synthetic nanocarriers. Cell membrane-coated nanoparticles are constructed by wrapping synthetic nanoparticle cores with membranes derived from various cell types. Membrane-coated nanoparticles provide a targeted and safe delivery system for drug therapy in tumors, mitigating the adverse effects associated with non-specific treatments. The camouflaging of nanoparticles with natural or artificially modified cell membranes enhances their properties, including longer circulation time, targeting capabilities for tumors or inflammation, and immune stimulation. CMNPs' biomimetic approach addresses key limitations of conventional nanoparticles, including rapid immune clearance, poor targeting specificity, and limited biocompatibility (Kaur et al., 2025).